SULLIVAN • STRUVE

INTERMEDIATE

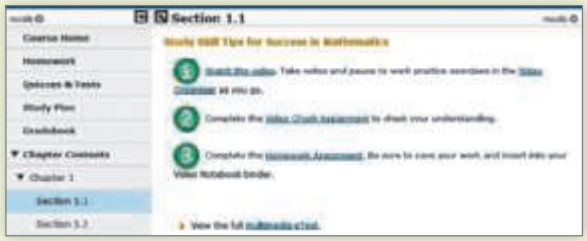
Algebra

FOURTH EDITION

Pearson

Get the Most Out of MyMathLab®

MyMathLab, Pearson's online homework, tutorial, and assessment program, creates personalized experiences for students and provides powerful tools for instructors. With a wealth of tested and proven resources, each course can be tailored to fit your specific needs.



Learning in any Environment

- Because classroom formats and student needs continually change and evolve, MyMathLab has built-in flexibility to accommodate various course designs and formats.
- With an updated and streamlined design, students and instructors can access MyMathLab from most mobile devices.

Personalized Learning

Not every student learns the same way or at the same rate. Thanks to our advances in adaptive learning technology capabilities, you no longer have to teach as if they do.

- MyMathLab's **adaptive Study Plan** acts as a personal tutor, updating in real-time based on student performance throughout the course to provide personalized recommendations for practice. You can now assign the Study Plan as a prerequisite to a test or quiz with **Companion Study Plan Assignments**.
- MyMathLab can **personalize homework assignments** for students based on their performance on a test or quiz. This way, students can focus on just the topics they have not yet mastered.

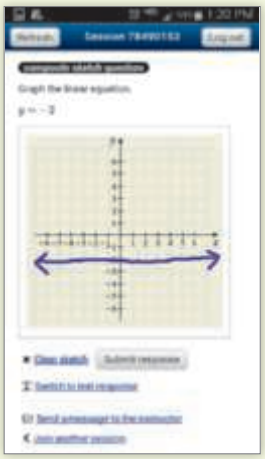
- **MyMathLab with Integrated Review courses**—available with selected titles for Developmental Mathematics through Calculus—can be used for just-in-time prerequisite review or for co-requisite courses. These courses provide videos on review topics, along with premade, assignable skill-review quizzes and personalized homework assignments integrated throughout your regular MyMathLab course content.

Visit www.mymathlab.com and click Get Trained to make sure you're getting the most out of MyMathLab.

Get the Most Out of Your Developmental Math MyMathLab Courses

Offer Step-by-Step Exercise Support

New Workspace Assignments allow students to naturally write out their work, step-by-step, and receive instant feedback at each step. Specific, relevant hints and videos are available to guide students through the steps. Each student's work is captured in the MyMathLab gradebook so you can easily pinpoint exactly where you need to focus your instruction.



Get Students Engaged

Learning Catalytics™—a student response tool that uses students' smartphones, tablets, or laptops to engage them in more interactive tasks and thinking— is available through any MyMathLab course to foster student engagement and peer-to-peer learning. You can generate class discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics.

Provide Adaptive Just-in-Time Practice

When students struggle on an exercise, Skill Builder Assignments provide just-in-time, targeted support to help them build up the requisite skills needed to complete their homework assignment. As students progress, these assignments adapt to provide support exercises that are personalized to each student's activity and performance throughout the course.

Use Data to Tailor Your Course

A comprehensive gradebook with enhanced reporting functionality helps you efficiently manage your course. The new Reporting Dashboard presents student performance data at the class, section, and program levels in an accessible, visual manner. Item Analysis allows you to track class-wide understanding at the exercise level, so that you can refine your lectures or assignments to address just-in-time student needs.

www.mymathlab.com

Intermediate Algebra

Fourth Edition

Michael Sullivan, III
Joliet Junior College

Katherine R. Struve
Columbus State Community College

with contributions by

Jessica Bernards
Portland Community College

Wendy Fresh
Portland Community College

Pearson

VP, Courseware Portfolio Management: Chris Hoag
Director, Courseware Portfolio Management: Michael Hirsch
Courseware Portfolio Manager: Mary Beckwith
Courseware Portfolio Management Assistant: Alison Oehman
Content Producer: Tamela Ambush
Managing Producer: Karen Wernholm
Producer: Audra Walsh
Manager, Courseware QA: Mary Durnwald
Manager, Content Development: Rebecca Williams
Product Marketing Manager: Alicia Frankel
Field Marketing Managers: Jennifer Crum and Lauren Schur
Product Marketing Assistant: Hanna Lafferty
Senior Author Support/Technology Specialist: Joe Vetere
Manager, Rights and Permissions: Gina Cheselka
Manufacturing Buyer: Carol Melville, LSC Communications
Associate Director of Design: Blair Brown
Text Design, Cover Design, and Composition: Cenveo Publisher Services
Cover Images: (grass) Val Lawless/Shutterstock; (cap) Angelo Gilardelli/Shutterstock;
(duck tape) Mexrix/Shutterstock

Library of Congress Cataloging-in-Publication Data

Names: Sullivan, Michael, III, 1967– | Struve, Katherine R.
Title: Intermediate algebra / Michael Sullivan, III, Joliet Junior College,
Katherine R. Struve, Columbus State Community College.
Description: 4th edition. | Boston : Pearson, [2018]
Identifiers: LCCN 2016020915| ISBN 9780134555805 (hardcover) | ISBN
0134555805 (hardcover) | ISBN 9780134556789 (hardcover) | ISBN 013455678X
(hardcover)
Subjects: LCSH: Algebra—Textbooks.
Classification: LCC QA154.3 .S785 2018 | DDC 512.9—dc23
LC record available at https://lccn.loc.gov/2016020915

1 16

Pearson

ISBN 13: 978-0-13-455580-5
ISBN 10: 0-13-455580-5

To my children, Michael, Kevin, and Marissa.

—Michael Sullivan

To my Family: Judy, Ruth, Leon, David, Patti, Terry, Madison, Mackenizie, Morgan, and Tegan

—Katherine R. Struve

About the Authors

With training in mathematics, statistics, and economics, Michael Sullivan, III has a varied teaching background that includes 27 years of instruction in both high school and college-level mathematics. He is currently a full-time professor of mathematics at Joliet Junior College. Michael has numerous textbooks in publication, including an Introductory Statistics series and a Precalculus series, which he writes with his father, Michael Sullivan.

Michael believes that his experiences writing texts for college-level math and statistics courses give him a unique perspective as to where students are headed once they leave the developmental mathematics tract. This experience is reflected in the philosophy and presentation of his developmental text series. When not in the classroom or writing, Michael enjoys spending time with his three children, Michael, Kevin, and Marissa, and playing golf. Now that his two sons are getting older, he has the opportunity to do both at the same time!

Kathy Struve has been a classroom teacher for nearly 35 years, first at the high school level and, for the past 27 years, at Columbus State Community College. Kathy embraces classroom diversity: diversity of students' age, learning styles, and previous learning success. She is aware of the challenges of teaching mathematics at a large, urban community college, where students have varied mathematics backgrounds and may enter college with a high level of mathematics anxiety.

Kathy served as Lead Instructor of the Developmental Algebra sequence at Columbus State, where she developed curriculum, conducted workshops, and provided leadership to adjunct faculty in the mathematics department. She embraces the use of technology in instruction, and has taught web and hybrid classes in addition to traditional face-to-face emporium-style classes. She is always looking for ways to more fully involve students in the learning process. In her spare time Kathy enjoys spending time with her two adult daughters, her four granddaughters, and biking, hiking, and traveling with her husband.

Contents

Preface

We would like to thank the reviewers, class testers, and users of the third edition of *Intermediate Algebra* who helped to make the book an overwhelming success. Their thoughtful comments and suggestions provided strong guidance for improvements to the fourth edition that we believe will enhance this solid, student-friendly text.

Intermediate Algebra is a gateway course to other college-level mathematics courses. The goal of the course is to provide students with the mathematical skills that are prerequisites for courses such as College Algebra, Elementary Statistics, Liberal-Arts Math, and Mathematics for Teachers. In addition, Intermediate Algebra must expose students to a variety of mathematical concepts that build on one another and that range from the basics such as linear equations to sophisticated concepts such as exponential functions.

Of particular importance in this course are rigor and mathematical thinking. It is imperative that the coverage be sufficiently rigorous to teach students how to study math successfully. At the same time, the course must develop students' ability to think mathematically. The rigor in the course exists both in the material presented (such as a more thorough development of functions) and in the array of problems and examples. As a result, it should be clear to students that this course is not simply a rehash of Elementary Algebra.

Most students have seen at least some of the content of this course at some point in their high school careers or in other college coursework. For some students, success at studying and facility with math concepts did not develop during their previous contact with the material, and they need a fresh start. In addition, the number of nontraditional students who have lost some of their math skills over the course of time continues to grow, especially at community colleges. Nontraditional students often are highly motivated to succeed because of their life experiences, yet they may be rusty at the business of "going to school." For nontraditional students, this course refreshes and reinforces their study skills as well as their mathematical skills.

To address the many needs and the diversity of today's Intermediate Algebra students, we have been guided by the following ideas as broad goals for this text:

- Provide the student with a strong conceptual foundation in mathematics through a clear, comprehensive presentation of topics with a special emphasis on functions.
- Present a variety of innovative pedagogical features, tools, study tips, and easy-to use aids to help students see the value of the text as an important resource and guide that will increase their success in the course.
- Provide comprehensive exercise sets with paired exercises that build problem-solving skills, show a variety of applications of mathematics, and reinforce mathematical concepts for students.
- Streamline the Intermediate Algebra course through the strategic placement of topics that will provide instructors with the flexibility to review material, as needed, instead of reteaching it.

New to the Fourth Edition

The revision of this text takes advantage of MyMathLab as a tool for learning. To address the needs of students who are exposed to the material almost exclusively through MyMathLab, we have introduced the following new features based on some of the hallmark features of the text to the program.

- Discovery activities using **applets** have been developed. These explorations are carefully crafted to allow students to develop understanding of mathematical concepts through experiential learning. The applets and guided exercises written that utilize the applets may be found in MyMathLab. The applets may also be accessed using the QR code at the beginning of the section.

- **Guided Exercises** are now available in MyMathLab based on the popular Showcase Examples. Showcase Examples from the text are easy to recognize with the words "How To" in the example title and provide step-by-step solutions to examples. This example structure was written into 55 *new* MyMathLab exercises that require students to respond to questions as the steps to solving problems are developed, similar to the "Help Me Solve This" feature of MyMathLab. This keeps the student completely engaged in the learning process and develops their conceptual understanding of the content. These exercises are easy to identify in the Assignment Builder as they are designated "How-To-#.# Ex#-<title abbreviation>. For example, "How-To-1.5 Ex3 How To Graph an Equation."
- **Quick Response (QR) codes**  now appear at each section opener, at section-level exercises, and as part of the Chapter Tests. Students can simply use a QR scanner from their smart phone for easy access to the popular Author in Action lecture videos, select end of section exercise videos, the discovery Applets, and the Chapter Test Prep videos.
- The authors developed a **Premade Author Created MyMathLab** course that utilizes all the new MyMathLab features. Each section has two MyMathLab assignments.
  - The first assignment is a multimedia assignment that incorporates the Author in Action lecture videos, the new applet discovery exercises, the new "How To" guided exercises, and the Quick Check exercises from the text. Recall, the Quick Check exercises follow many of the examples in the text. To assist students in utilizing the text, the Textbook learning aid for each Quick Check exercise will link *directly* to the corresponding example in the text. All learning aids, with the exception of "View an Example", will be available for this portion of the homework. Our experience as instructors has been that too many students rely on this learning aid while doing homework, thereby reducing the effect of homework as students simply mimic the View an Example content.
  - The second assignment is based on the Skill Building and Mixed Practice exercises from the text. Skill building exercises are tied to objectives within the text, so the Textbook learning aid will link directly to the objective within the section. The idea is to reduce the amount of guidance provided to the student (compared with Quick Check exercises) so they are more responsible for identifying the problem type. The Mixed Practice exercises are based on multiple concepts learned within the section or text, so the Textbook learning aid is linked to the section. The student must determine the problem type based on Quick Check and Skill Building exercise experience. The "View an Example" learning aid is disabled for this exercise set as well. Because this text has Skill Builder available in MyMathLab, you may consider reducing the number of exercises in the second assignment. By checking the Skill Builder box, the assignments will adapt to provide support exercises personalized to each student's needs.

Build a Strong Foundation Through a Functions Approach

The approach that we take in Intermediate Algebra is that the function is the overriding theme of the text. The reason for this stress on functions is twofold. First, Intermediate Algebra is not a terminal course but rather a gateway to the future, and functions form the basis for much study in mathematics. The introduction of functions helps make the "jump" from Intermediate Algebra to College Algebra less severe because students feel more comfortable with functions and function notation. Second, today's students like to learn in context so that they can see the relevancy of the material. The function provides a great way to present the usefulness of the material we are teaching.

Develop an Effective Text for Use In and Out of the Classroom

Given the hectic lives led by most students, coupled with the anxiety and trepidation with which they approach this course, an outstanding developmental mathematics text must provide pedagogical support that makes the text valuable to students as they study and do assignments. Pedagogy must be presented within a framework that teaches students how to study math; pedagogical devices must also address what students see as the "mystery" of mathematics—and solve that mystery.

To encourage students and to clarify the material, we developed a set of pedagogical features that help students develop good study skills, garner an understanding of the connections between topics, and work smarter in the process. The pedagogy used is based upon the more than 70 years of classroom teaching experience that the authors bring to this text.

Examples are often the determining factor in how valuable a textbook is to a student. Students look to examples to provide them with guidance and instruction when they need it most—the times when they are away from the instructor and the classroom. We have developed several example formats in an attempt to provide superior guidance and instruction for students. The formats include:

Innovative Sullivan/Struve Examples

The innovative *Sullivan/Struve Example* has a two-column format in which annotations are provided to the **left** of the algebra, rather than the right, as is the practice in most texts. Because we read from **left to right,** placing the annotation on the left will make more sense to the student. It becomes clear that the annotation describes what we are about to do instead of what was just done. The annotations may be thought of as the teacher's voice offering clarification immediately before writing the next step in the solution on the board. Consider the following:

EXAMPLE 6 **Solving Linear Inequalities**

Solve the inequality: $x - 4 \geq 5x + 12$

Solution

$$x - 4 \geq 5x + 12$$

Add 4 to both sides: $x - 4 + 4 \geq 5x + 12 + 4$

$$x \geq 5x + 16$$

Subtract $5x$ from both sides: $x - 5x \geq 5x + 16 - 5x$

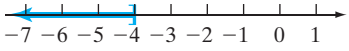
$$-4x \geq 16$$

Divide both sides by -4. Don't forget to change the direction of the inequality: $\frac{-4x}{-4} \leq \frac{16}{-4}$

$$x \leq -4$$

The solution using set-builder notation is $\{x \mid x \leq -4\}$. The solution using interval notation is $(-\infty, -4]$. See Figure 20 for the graph of the solution set. ●

Figure 20



Quick ✓

In Problems 20–22, solve each linear inequality. Write the solution using set-builder notation and interval notation. Graph the solution set.

20. $3x + 1 > x - 5$

21. $-2x + 1 \leq 3x + 11$

22. $-5x + 12 < x - 3$

Showcase Examples

Showcase Examples are used strategically to introduce key topics or important problem solving techniques. These examples provide "how-to" instruction by offering

a guided, step-by-step approach to solving a problem. Students can then immediately see how each of the steps is employed. We remind students that the *Showcase Example* is meant to provide "how-to" instruction by including the words "how to" in the example title. The *Showcase Example* has a three-column format in which the left column describes a step, the middle column provides a brief annotation, as needed, to explain the step, and the right column presents the algebra. With this format, students can see each step in the problem-solving process in context so that the steps make more sense. This approach is more effective than simply stating each step in the text.

EXAMPLE 9 **How to Solve an Inequality Involving $>$**

Solve the inequality $|2x - 5| > 3$. Express the solution set in set-builder notation and interval notation. Graph the solution set.

Step-by-Step Solution

Step 1: The inequality is in the form $|u| > a$, where $u = 2x - 5$ and $a = 3$. Rewrite the inequality as a compound inequality that does not involve absolute value.

$$|2x - 5| > 3$$

$|u| > a$ means $u < -a$ or $u > a$: $2x - 5 < -3$ or $2x - 5 > 3$

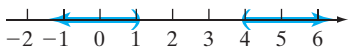
Step 2: Solve each inequality separately.

	$2x - 5 < -3$		$2x - 5 > 3$
Add 5 to both sides:	$2x < 2$	Add 5 to both sides:	$2x > 8$
Divide both sides by 2:	$x < 1$	Divide both sides by 2:	$x > 4$

Step 3: Find the union of the solution sets of each inequality.

The solution set is $\{x|x < 1 \text{ or } x > 4\}$ or, using interval notation, $(-\infty, 1) \cup (4, \infty)$. See Figure 47 for the graph of the solution set.

Figure 47



Work Smart

$|u| > a$
CANNOT be written as
$-a > u > a$

Quick ✓

34. $|x - 9| > 6$ is equivalent to $x - 9 > 6$ or $x - 9$ ___ -6.

In Problems 35–40, solve each inequality. Express the solution set in set-builder notation and interval notation. Graph the solution set.

35. $|x + 3| > 4$

36. $|4x - 3| \geq 5$

37. $|-3x + 2| > 7$

38. $|2x + 5| - 2 > -2$

39. $|6x - 5| \geq 0$

40. $|2x + 1| > -3$

Quick Check Exercises

Placed at the conclusion of most examples, the *Quick Check* exercises provide students with an opportunity for immediate reinforcement. By working the problems that mirror the example just presented, students get instant feedback and gain confidence in their understanding of the concept. All *Quick Check* exercises answers are provided in the back of the text. The *Quick Check* exercises should be assigned as homework to encourage students to read, consult, and use the text regularly.

Superior Exercise Sets: Paired with Purpose

Students learn algebra by doing algebra. The superior end-of-section exercise sets in this text provide students with ample practice of both procedures and concepts. The exercises are paired and present problem types with every possible derivative. The

exercises also present a gradual increase in difficulty level. The early, basic exercises keep the student's focus on as few "levels of understanding" as possible. The later or higher-numbered exercises are "multi-task" (or Mixed Practice) exercises where students are required to utilize multiple skills, concepts, or problem-solving techniques.

Throughout the textbook, the exercise sets are grouped into nine categories—some of which appear only as needed:

1. **Are You Prepared For This Section?** problems are located at the opening of the section. They are problems that deal with prerequisite material for the section along with page references so students may remediate, if necessary. Answers to the Prepared? . . . problems appear as a footnote on the page.

2. **Quick Check** exercises, which provide the impetus to get students into the text, follow most examples and are numbered sequentially as the first problems in each section exercise set. By doing these problems as homework and the first exercises attempted, the student is directed into the material in the section. If a student gets stuck, he or she will learn that the example immediately preceding the Quick Check exercise illustrates the concepts needed to solve the problem.

3. **Building Skills** exercises are drill problems that develop the student's understanding of the procedures and skills in working with the methods presented in the section. These exercises can be linked back to a single objective in the section. Notice that the Building Skills problems begin the numbering scheme where the Quick Checks leave off. For example, if the last Quick Check exercise is Problem 20, then we begin the Building Skills exercises with Problem 21. This serves as a reminder that Quick Check exercises should be assigned as homework.

4. **Mixed Practice** exercises are also drill problems, but they offer a comprehensive assessment of the skills learned in the section by asking problems that relate to more than one concept or objective. In addition, we may present problems from previous sections so students must first recognize the type of problem and then employ the appropriate technique to solve the problem.

5. **Applying the Concepts** exercises are problems that allow students to see the relevance of the material learned within the section. Problems in this category either are situational problems that use material learned in the section to solve "real-world" problems or are problems that ask a series of questions to enhance a student's conceptual understanding of the mathematics presented in the section.

6. **Extending the Concepts** exercises can be thought of as problems that go beyond the basics. Within this block of exercises an instructor will find a variety of problems to sharpen students' critical-thinking skills.

7. **Explaining the Concepts** problems require students to think about the big picture concepts of the section and express these ideas in their own words. It is our belief that students need to improve their ability to communicate complicated ideas both orally and in writing. When they are able to explain mathematical methods or concepts to another individual, they have truly mastered the ideas. These problems can serve as a basis for classroom discussion or can be used as writing assignments.

8. Starting with Chapter 5, we provide **Synthesis Review** exercises to help students grasp the "big picture" of algebra—once they have a sufficient conceptual foundation to build upon from their work in Chapters R through 4. Synthesis Review exercises ask students to perform a single operation (adding, solving, and so on) on several objects (polynomials, rational expressions, and so on). The student is then asked to discuss the similarities and differences in performing the same operation on the different objects.

9. Finally, we include **technology exercises.** Instructors' philosophies about the use of graphing technology, such as graphing calculators, GeoGebra, or Desmos to solve problems vary considerably. Because instructors disagree about the value of these tools, we have made an effort to make graphing technology entirely optional. When appropriate, technology exercises are included at the close of a section's exercise set. Also included in the technology exercises are the new applet explorations. The applets may be found in MyMathLab or using the Quick Response (QR) code located in the section opener ribbon.

Problem Icons In addition to the carefully structured categories of exercises, selected problems are flagged with icons to denote that:

- Problems whose number is green have complete worked-out solutions found in MyMathLab.
- △ These problems focus on geometry concepts.

Hallmark Features of Sullivan/Struve

Author in Action Videos

The Author in Action videos are videos of the authors presenting the content. Most of the videos are from the authors' actual classroom lectures. This makes the videos authentic and gives the viewer the sense of participating in the lecture. The videos are tied to the objectives and under 12 minutes in length. For those objectives that require more than 12 minutes, we have multiple videos. Students are alerted to the availability of a video with the icon. The videos are available in MyMathLab, the Multimedia Textbook (in MyMathLab), or through a Quick Response (QR) code located in the section opener ribbon. The videos are captioned in English and Spanish.

Video Notebook

A video notebook is available, which is ideal for online, emporium/redesign courses, or inverted (flipped) classrooms. This video notebook assists students in taking thorough, organized, and understandable notes as they watch the Author in Action videos by asking students to complete definitions, procedures, and examples based on the content of the videos.

Streamlining Intermediate Algebra: *Getting Ready for Chapter . . .* Review Sections

To maintain the pace of the course, we created several ***Getting Ready*** sections that review material taught in Elementary Algebra courses. The *Getting Ready* sections are designed to allow students to brush up on topics and skills as needed before beginning the chapters in the Intermediate Algebra text where the skills will be used or further developed. These optional, yet integrated, sections provide the student with timely review. They also streamline the Intermediate Algebra course by providing the instructors with the flexibility to decide if the *Getting Ready* sections should be covered in their entirety, briefly reviewed, or skipped, depending upon the needs of their students. *Getting Ready* review sections have been placed before Chapters 4, 5, and 6 in the text.

Quick Check Exercises: Encourage Study Skills that Lead to Independent Learning

What is one of the overarching goals of an education? We believe it is to learn to solve problems independently. In particular, we would like to see students develop the ability to pick up a text or manual and teach themselves the skills they need. In our mathematics classes, however, we are often frustrated because students rarely read the text and often struggle to understand the concepts independently.

To encourage students to use the text more effectively and to help them achieve greater success in the course, we have structured the exercises in the fourth edition of our text differently from other mathematics textbooks. The aim of this structure is to get students "into the text" in order to increase their ability and confidence to work any math problem—particularly when they are away from the classroom and an instructor who can help.

Each section's exercise set begins with *Quick Check* exercises. The *Quick Checks* are consecutively numbered. The end-of-section exercises begin their numbering scheme based on where the *Quick Checks* end. For example:

- Section 1.1: *Quick Checks* end at Problem 30, so the end-of-section exercise set starts with Problem 31 (see page 57).
- Section 1.2: *Quick Checks* end at Problem 30, so the end-of-section exercise set starts with Problem 31 (see page 70).

The *Quick Checks* follow most examples and provide the platform for students to get "into the text." By integrating these exercises into the exercise set, we direct students to the instructional material in that section. Our hope is that students will then become more aware of the instructional value of the text and will be more likely to succeed when studying away from the classroom and the instructor.

Answer annotations to Quick Checks and exercises have been placed directly next to each problem in the Annotated Instructor's Edition to make it easier for instructors to create assignments.

We have used the same background color for the Quick Checks and the exercise sets to reinforce the connection between them visually. The colored background will also make the Quick Checks easier to find on the page.

Answers to Selected Exercises at the back of the text integrate the answers to *every* Quick Check exercise with the answers to *every odd* problem from the section exercise sets.

Study Skills and Student Success

We have included study skills and student success as regular themes throughout this text starting with *Section R.1, Success in Mathematics*. In addition to this dedicated section that covers many of the basics that are essential to success in any math course, we have included several recurring study aids that appear in the margin. These features were designed to anticipate the student's needs and to provide immediate help—as if the teacher were looking over his or her shoulder. These margin features include *In Other Words; Work Smart;* and *Work Smart: Study Skills*.

Section R.1: *Success in Mathematics* focuses the student on basic study skills, including what to do during the first week of the term; what to do before, during, and after class; how to use the text effectively; and how to prepare for an exam.
In Other Words helps to address the difficulty that students have in reading mathematically precise definitions and theorems by explaining them in easier to understand language.
Work Smart provides "tricks of the trade" hints, tips, reminders, and alerts. It also identifies some common errors to avoid and helps students work more efficiently.
Work Smart: Study Skills reminds students of study skills that will help them to succeed at various points in the course. Attention to these practices will help them to become better, more proficient learners.

Test Preparation and Student Success

The Chapter Tests in this text and the companion Chapter Test Prep Videos have been designed to help students make the most of their valuable study time.

Chapter Test In preparation for their classroom test, students should take the practice test to make sure they understand the key topics in the chapter. The exercises in the Chapter Tests have been crafted to reflect the level and types of exercises a student is likely to see on a classroom test.

Chapter Test Prep Video The Chapter Test Prep Videos provide students with help at the critical juncture when they are studying for a test. The videos present step-by-step solutions to the exact exercises found in each of the book's Chapter Tests. Easy video navigation allows students instant access to the worked-out solutions to the exercises they want to study or review. These videos are available in MyMathLab or may be accessed using the QR code in the Chapter Test ribbon.

How It All Fits Together: The Big Picture

Another important role of the pedagogy in this text is to help students see and understand the connection among the mathematical topics being presented. Several section-opening and margin features help to reinforce connections:

The Big Picture: Putting It Together **(Chapter Opener)** This feature is based on how we start each chapter in the classroom—with a quick sketch of what we plan to cover. Before tackling a chapter, we tie concepts and techniques together by summarizing material covered previously and then relate these ideas to material we are about to discuss. It is important for students to understand that content truly builds from one chapter to the next. We find that students need to be reminded that the familiar operations of addition, subtraction, multiplication, and division are being applied to different or more complex objects.

Are You Prepared for This Section? As part of this building process, we think it is important to remind students of specific concepts or skills that they will need from earlier in the course to be successful within a given section. The *Are You Prepared?* feature that begins each section not only provides a list of prerequisite skills that a student should understand before tackling the content of a new section but also offers a short set of problems to test students' preparedness. Answers to the problems are provided in a footnote on the same page, and a cross-reference to the material in the text is provided so that the student can remediate when necessary.

Putting the Concepts Together **(Mid-Chapter Review)** Each chapter has a group of exercises at the appropriate point in the chapter, entitled *Putting the Concepts Together.* These exercises serve as a review—synthesizing material introduced up to that point in the chapter. The exercises in these mid-chapter reviews are carefully chosen to assist students in seeing the "big picture."

Synthesis Review Exercises Starting with Chapter 5, we provide Synthesis Review exercises to help students grasp the "big picture" of algebra—once they have a sufficient conceptual foundation to build upon from their work in Chapters R through 4.

Cumulative Review Learning algebra is a building process, and building involves considerable reinforcement. The Cumulative Review exercises at the end of each odd-numbered chapter, starting with Chapter 1, help students reinforce and solidify their knowledge by revisiting concepts and using them in context. This way, studying for the final exam should be fairly easy. Cumulative Reviews for each even-numbered chapter can be found on the Instructor's Resource Center. Answers to all cumulative review problems appear in the back of the text.

In Closing

When we started writing this textbook, we discussed improvements we could make in coverage; in staples such as examples and problems; and in any pedagogical features that we found truly useful. After writing and rewriting, and reading many thoughtful reviews from instructors, we focused on the following features of the text to set it apart.

- **Functions** are introduced early and revisited often throughout the course. This integration helps prepare students for the quantitative courses that they will take after Intermediate Algebra.
- The innovative ***Sullivan/Struve Examples*** and ***Showcase Examples*** provide students with superior guidance and instruction when they need it most—when they are away from the instructor and the classroom. Each of the margin features

In Other Words, Work Smart, and ***Work Smart: Study Skills*** are designed to improve study skills, make the textbook easier to navigate, and increase student success.

- **Exercise Sets: Paired with Purpose**—The exercise sets are structured to assess student understanding of vocabulary, concepts, drill, problem solving, and applications. The exercise sets are graded in difficulty level to build confidence and to enhance students' mathematical thinking. The ***Quick Check*** exercises provide students with immediate reinforcement and instant feedback to determine their understanding of the concepts presented in the examples. ***Putting the Concepts Together*** and ***Synthesis Review*** help students see the big picture and provide a structure for learning each new concept and skill in the course.
- The text is written to streamline Intermediate Algebra (and distinguish it from Elementary Algebra) through a single-chapter presentation of linear equations and inequalities along with the strategic placement of ***Getting Ready*** review sections that provide instructors with the flexibility to review material instead of reteaching it.

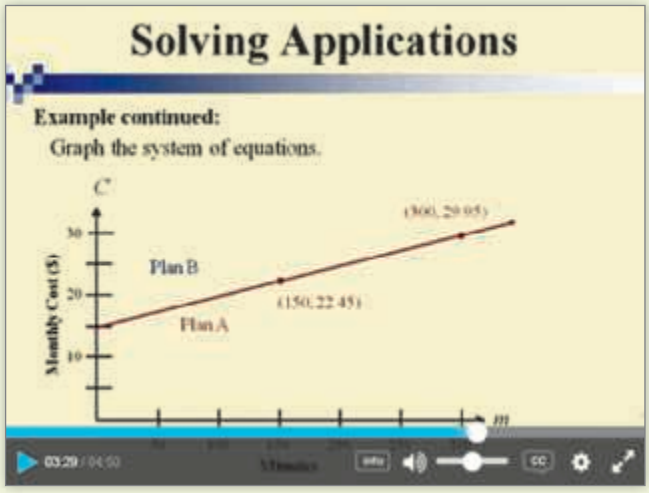
Resources for Success

MyMathLab Online Course for Sullivan/Struve, *Intermediate Algebra*, 4th edition

To give students a consistent tone, voice, and teaching method, this text's approach is tightly integrated throughout its accompanying MyMathLab course, making learning the material as seamless as possible. This course contains all of MyMathLab's powerful features, in addition to specific Sullivan/Struve tools.

Premade Author Created MyMathLab Course

A premade course developed by the authors with a guided learning path for students allows instructors the ease of quick start-up, and encourages students to learn and retain the concepts in order to be more successful on their homework. The learning path guides students to first take advantage of the learning resources at their disposal, including videos and new applets, before directing them to their assignments, which are premade. The MyMathLab course is set up to help instructors get the most out of their course, but all assignments are able to be tailored to instructors' needs.



Robust Video Program

The wealth of video resources in the MyMathLab course give students just-in-time help at home, in the lab, or on the go. Video resources include:

- Author-in-Action videos featuring author Mike Sullivan's actual classroom lecture
- Example-level solution clips
- Chapter Test Prep videos

New QR codes located throughout the textbook give students instant, easy access to all the videos at their fingertips.

New Applets

New applets developed by the authors let students interact with the math in a visual, tangible way. These animations allow students to explore and manipulate the mathematical concepts, leading to more durable understanding, and corresponding exercises in MyMathLab make them truly assignable.

Guided Exercises

In addition to MyMathLab's hallmark interactive exercises, Guided Exercises walk students through each step of the problem-solving process, giving them a truly guided, step-by-step learning experience. These are based on the "How To" exercises from the text and were written by the authors.

www.mymathlab.com

Resources for Success

Instructor Resources

Annotated Instructor's Edition

ISBN 10: 013455678X **ISBN 13:** 9780134556789

The AIE provides annotations for instructors, including answers and teaching tips.

The following resources can be downloaded from www.pearsonhighered.com or in MyMathLab.*

Instructor Solutions Manual

This manual provides worked-out solutions to all exercises in the text.

Instructor's Resource Manual

This manual includes resources designed to help both new and experienced instructors with course preparation and classroom management. This includes mini-lectures for each section of the text, chapter by chapter teaching tips, sample syllabi, and more.

PowerPoints

These slides present key concepts and definitions from the text.

TestGen

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text.

*To access our Instructor Resource Center (IRC), please go to http://www.pearsonhighered.com/pearsonhigheredus/educator/catalog/index.page?null and follow the prompts. Once approved for online access, you will receive an email containing instructions on how to redeem your code and create your login name and password.

Student Resources

Author in Action videos

Available in MyMathLab, these videos feature each objective presented by the authors with detailed explanations and examples.

Student Solutions Manual

ISBN 10: 0134556763 **ISBN 13:** 9780134556765

This manual contains complete worked solutions to the odd-numbered problems in the end-of-section exercise sets and all of the Quick Checks and end-of-chapter exercises.

Video Notebook

ISBN 10: 0134592069 **ISBN 13:** 9780134592060

The Video Notebook is an unbound, three-hole-punched workbook/note-taking guide that students use in conjunction with the Sullivan/Struve/Mazzarella "Author in Action" videos. The notebook helps them develop organized notes as they work along with the videos.

- A Video Guide for each section is organized by learning objective. Typically, there is one Author in Action video per objective, and students are asked to write down important definitions and procedures and work through key examples as they watch the video.
- The clean layout and ample space let students write out full definitions and show all work for the examples.
- The unbound, loose-leaf format allows students to insert additional notes from class and/or homework—so they can build a course notebook and good study skills for future classes!

Do The Math Workbook

ISBN 10: 0134556674 **ISBN 13:** 9780134556673

This workbook offers a collection of 5-Minute Warm-Up exercises, Guided Practice exercises, and Do the Math exercises for each section in the text. These worksheets can be used as in-class assignments, as an in-lab study assignment, or for homework.

Acknowledgments

Textbooks are written by authors but evolve through the efforts of many people. We would like to extend our thanks to the following individuals for their important contributions to the project. From Pearson: Mary Beckwith, whose editorial expertise has been an invaluable asset; Michelle Renda for her innovative marketing ideas; Chris Hoag for her support and encouragement; Heather Scott and the design team for the attractive and functional design; Rose Kernan, Patty Bergin and Lauren Morse for keeping a watchful eye and managing countless production details and finally, the Pearson Arts & Sciences sales team for their confidence and support of our books.

We would also like to thank Brad Davis and John Bialas for their attention to details and consistency in accuracy checking the text and answer sections. A huge thanks goes out to Val Villegas, who created the outstanding classroom video notebooks that accompany the text. We offer many thanks to all the instructors from across the country who participated in reviewer conferences and focus groups, reviewed or class-tested some aspect of the manuscript, and taught from the previous editions. Their insights and ideas form the backbone of this text. Hundreds of instructors contributed their time, energy, and ideas to help us shape this text. We will attempt to thank them all here. We apologize for any omissions.

The following individuals, many of whom reviewed or class-tested the first edition, provided direction and guidance in shaping the fourth edition.

Marwan Abu–Sawwa, *Florida Community College—Jacksonville*
MaryAnne Anthony, *Santa Ana College*
Darla Aguilar, *Pima State University*
Grant Alexander, *Joliet Junior College*
Philip Anderson, *South Plains College*
Mary Lou Baker, *Columbia State Community College*
Bill Bales, *Rogers State*
Tony Barcellos, *American River College*
John Beachy, *Northern Illinois University*
Donna Beatty, *Ventura College*
David Bell, *Florida Community College—Jacksonville*
Sandy Berry, *Hinds Community College*
John Bialas, *Joliet Junior College*
Linda Blanco, *Joliet Junior College*
Kevin Bodden, *Lewis and Clark College*
Rebecca Bonk, *Joliet Junior College*
Cherie Bowers, *Santa Ana College*
Becky Bradshaw, *Lake Superior College*
Lori Braselton, *Georgia Southern University*
Tim Britt, *Jackson State Community College*
Beverly Broomell, *Suffolk Community College*
Joanne Brunner, *Joliet Junior College*
Hien Bui, *Hillsborough Community College—Dale Mabry*
Connie Buller, *Metropolitan Community College*
Annette Burden, *Youngstown State University*
James Butterbach, *Joliet Junior College*
Marc Campbell, *Daytona Beach Community College*
Elena Catoiu, *Joliet Junior College*
Nancy Chell, *Anne Arundel Community College*
John F. Close, *Salt Lake Community College*
Bobbi Cook, *Indian River Community College*
Carlos Corona, *San Antonio College*
Faye Dang, *Joliet Junior College*
Shirley Davis, *South Plains College*
Vivian Dennis-Monzingo, *Eastfield College*
Alvio Dominguez, *Miami Dade Community College—Wolfson*
Karen Driskell, *South Plains College*
Thomas Drucker, *University of Wisconsin—Whitewater*
Brenda Dugas, *McNeese State University*
Doug Dunbar, *Okaloosa-Walton Junior College*
Laura Dyer, *Southwestern Illinois State University*
Bill Echols, *Houston Community College—Northwest*
Laura Egner, *Joliet Junior College*
Jason Eltrevoog, *Joliet Junior College*
Nancy Eschen, *Florida Community College—Jacksonville*
Mike Everett, *Santa Ana College*
Phil Everett, *Ohio State University*
Scott Fallstrom, *Shoreline Community College*
Betsy Farber, *Bucks County Community College*
Fitzroy Farqharson, *Valencia Community College—West*
Stephanie Fluke, *Austin Community College*
Jacqueline Fowler, *South Plains College*
Dorothy French, *Community College of Philadelphia*
Randy Gallaher, *Lewis and Clark College*
Sanford Geraci, *Broward Community College*
Donna Gerken, *Miami Dade Community College—Kendall*
Adrienne Goldstein, *Miami Dade Community College—Kendall*
Marion Graziano, *Montgomery County Community College*
Susan Grody, *Broward Community College*
Tom Grogan, *Cincinnati State University*
Barbara Grover, *Salt Lake Community College*
Shawna Haider, *Salt Lake Community College*
Margaret Harris, *Milwaukee Area Technical College*
Teresa Hasenauer, *Indian River Community College*
Mary Henderson, *Okaloosa-Walton Junior College*
Celeste Hernandez, *Richland College*
Paul Hernandez, *Palo Alto College*
Pete Herrera, *Southwestern College*
Bob Hervey, *Hillsborough Community College—Dale Mabry*
Teresa Hodge, *Broward Community College*
Sandee House, *Georgia Perimeter College*
Becky Hubiak, *Tidewater Community College—Virginia Beach*
Sally Jackman, *Richland College*
John Jarvis, *Utah Valley State College*
Nancy Johnson, *Broward Community College*
Steven Kahn, *Anne Arundel Community College*
Linda Kass, *Bergen Community College*
Donna Katula, *Joliet Junior College*
Mohammed Kazemi, *University of North Carolina—Charlotte*
Doreen Kelly, *Mesa Community College*

Mike Kirby, *Tidewater Community College—Virginia Beach*
Keith Kuchar, *College of Dupage*
Carla Kulinsky, *Salt Lake Community College*
Julie Labbiento, *Leigh Carbon Community College*
Kathy Lavelle, *Westchester Community College*
Deanna Li, *North Seattle Community College*
Brian Macon, *Valencia Community College—West*
Iris Magee, *Los Angeles City College*
Lynn Marecek, *Santa Ana College*
Jim Matovina, *Community College of Southern Nevada*
Jean McArthur, *Joliet Junior College*
Michael McComas, *Marshall University*
Mikal McDowell, *Cedar Valley College*
Lee McEwen, *Ohio State University*
David McGuire, *Joliet Junior College*
Angela McNulty, *Joliet Junior College*
Debbie McQueen, *Fullerton College*
Judy Meckley, *Joliet Junior College*
Lynette Meslinsky, *Erie Community College—City Campus*
Kausha Miller, *Lexington Community College*
Chris Mizell, *Okaloosa Walton Junior College*
Jim Moore, *Madison Area Technical College*
Ronald Moore, *Florida Community College—Jacksonville*
Elizabeth Morrison, *Valencia Community College—West*
Roya Namavar, *Rogers State*
Hossein Navid-Tabrizi, *Houston Community College*
Carol Nessmith, *Georgia Southern University*
Kim Neuburger, *Portland Community College*
Larry Newberry, *Glendale Community College*
Elsie Newman, *Owens Community College*
Charlotte Newsome, *Tidewater Community College*
Charles Odion, *Houston Community College*
Viann Olson, *Rochester Community and Technical College*
Linda Padilla, *Joliet Junior College*
Carol Perry, *Marshall Community and Technical College*
Faith Peters, *Miami Dade Community College—Wolfson*
Dr. Eugenia Peterson, *Richard J. Daley College*
Jean Pierre-Victor, *Richard J. Daley College*
Philip Pina, *Florida Atlantic University*
Carol Poos, *Southwestern Illinois University*
Elise Price, *Tarrant County Community College*
R.B. Pruitt, *South Plains College*
William Radulovich, *Florida Community College—Jacksonville*
Pavlov Rameau, *Miami Dade Community College—Wolfson*
David Ray, *University ofTennessee—Martin*
Nancy Ressler, *Oakton Community College*
Michael Reynolds, *Valencia Community College—West*
George Rhys, *College of the Canyons*
Jorge Romero, *Hillsborough Community College—Dale Mabry*
David Ruffato, *Joliet Junior College*
Carol Rychly, *Augusta State University*
David Santos, *Community College of Philadelphia*
Togba Sapolucia, *Houston Community College*
Doug Smith, *Tarrant Community College*
Catherine J.W. Snyder, *Alfred State College*
Gisela Spieler-Persad, *Rio Hondo College*
Raju Sriram, *Okaloosa-Walton Junior College*
Patrick Stevens, *Joliet Junior College*
Bryan Stewart, *Tarrant Community College*
Jennifer Strehler, *Oakton Community College*
Elizabeth Suco, *Miami Dade Community College—Wolfson*
Katalin Szucs, *East Carolina University*
KD Taylor, *Utah Valley State College*
Mary Ann Teel, *University of North Texas*
Suzanne Topp, *Salt Lake Community College*
Suzanne Trabucco, *Nassau Community College*
Jo Tucker, *Tarrant Community College*
Bob Tuskey, *Joliet Junior College*
Mary Vachon, *San Joaquin Delta College*
Carol Walker, *Hinds Community College*
Kim Ward, *Eastern Connecticut State University*
Richard Watkins, *Tidewater Community College*
Natalie Weaver, *Daytona Beach Community College*
Darren Wiberg, *Utah Valley State College*
Rachel Wieland, *Bergen Community College*
Christine Wilson, *Western Virginia University*
Brad Wind, *Miami Dade Community College—North*
Roberta Yellott, *McNeese State University*
Steve Zuro, *Joliet Junior College*
Jon Anderson, *Utah Valley University*
Darren Wiberg, *Utah Valley University*
Rick Woodmansee, *Sacramento City College*

Additional Acknowledgments

We also would like to extend thanks to our colleagues at Joliet Junior College and Columbus State Community College, who provided encouragement, support, and the teaching environment where the ideas and teaching philosophies in this text were developed.

Michael Sullivan, III
Katherine R. Struve

This page intentionally left blank

CHAPTER

R Review

The image to the left of a sun carrier shell fossil (*Stellaria solaris*) demonstrates how a specific sequence of numbers, called the Fibonacci sequence, occurs frequently in nature. Problem 142 in Section R.3 explores the Fibonacci sequence further.

The Big Picture: Putting It Together

As the "R" in the title implies, this chapter is a review. The purpose of this chapter is to help you recall mathematical concepts that you learned in earlier courses. The topics in this chapter are important building blocks that will help you succeed in this course.

Your instructor may or may not decide to cover this chapter, depending on the course syllabus. Regardless, as you proceed through the book, references will be made to Chapter R so that you can use it as a "just-in-time" review.

Outline

R.1 Success in Mathematics

Objectives

1. What to Do the First Week of the Semester
2. What to Do Before, During, and After Class
3. How to Use the Text Effectively
4. How to Prepare for an Exam

Let's start by having a discussion about the big picture goals of the course and how this text can help you be successful at mathematics. Our first "big picture" goal is to develop algebraic skills and gain an appreciation for the power of algebra and mathematics. But there is also a second "big picture" goal. By studying mathematics, we develop a sense of logic and exercise the part of our brains that deals with logical thinking. The examples and problems in this text are like the crunches we do in a gym to exercise our bodies. The goal of running or walking is to get from point A to point B, so doing fifty crunches on a mat does not accomplish that goal, but crunches do make our upper bodies, backs, and hearts stronger for when we need to run or walk.

Logical thinking can assist us in solving difficult everyday problems, and solving algebra problems "builds the muscles" in the part of our brain that performs logical thinking. So, when you are studying algebra and getting frustrated with the amount of work that needs to be done, and you say, "My brain hurts," remember that just like an athlete, you must practice to be successful. But as is also true of an athlete, practice needs to be on a regular basis, not just before "the big game."

Another phrase to keep in mind is "Success breeds success." Mathematics is everywhere. You already are successful at doing some everyday mathematics. With practice, you can take your initial successes and become even more successful. Have you ever done any of the following everyday activities?

- Double a cookie recipe.
- Leave a tip at a restaurant.
- Figure out how many calories your bowl of breakfast cereal provides.
- Compare the distances between cities as you plan a vacation.
- Order the appropriate number of gallons of paint to cover the walls of a room.
- Buy a car and take out a car loan with interest.
- Compare the price per ounce of different sizes of jars of peanut butter or jam.
- Exchange American dollars for Canadian dollars.
- Find the final price on a t-shirt after applying a 20%-off coupon.

You may do five or ten mathematical activities in a single day! The everyday mathematics that you already know is the foundation for your success in this course.

1 What to Do the First Week of the Semester

The first week of the semester gives you the opportunity to prepare for a successful course. Here are the things you should do:

1. **Pick a good seat.** Choose a seat that gives you a good view of the room. Sit close enough to the front so you can easily see the board and hear the professor.
2. **Read the syllabus to learn about your instructor and the course.** Take note of your instructor's name, office location, e-mail address, telephone number, and office hours. Pay attention to any additional help such as tutoring centers, videos, software, and online tutorials. Be sure you fully understand all of the instructor's policies for the class, including those on absences, missed exams or quizzes, and homework. Know important dates and put them in your planner, tablet, computer, or phone. Ask questions.
3. **Learn the names of some of your classmates and exchange contact information.** One of the best ways to learn math is through group study sessions. Try to create time each week to study with your classmates. Knowing how to get in contact with classmates is also useful, because you can obtain the assignment for the day if you ever miss class.

Work Smart: Study Skills

Plan on studying at least two hours outside of class for each hour in class every week.

4. **Budget your time.** Most students have a tendency to "bite off more than they can chew." To help with time management, consider the following general rule: Plan on studying *at least* two hours outside of class for each hour in class. So, if you enrolled in a four-hour math class, you should set aside at least eight hours each week to study for the course. You will also need to set aside time for other courses. Consider your work schedule and personal life when creating your time budget. A blank time chart is provided in the exercises for you to use to manage your time.
5. **Get a notebook or binder that is dedicated to math alone.** Don't use this notebook for any other classes, just math, so you stay organized.

❷ What to Do Before, During, and After Class

Now that the semester is under way, we present the following ideas for what to do before, during, and after each class meeting. These suggestions may sound overwhelming, but by following them, you will increase your chances to be successful in mathematics (and other courses). Also, you will find that following this plan will make studying for exams much easier.

Before Class

Work Smart:

Creating these habits at the beginning of the semester will be easier than waiting for the material to get too difficult.

1. Read the section or sections that will be covered in the upcoming class meeting. Watch the video lectures that accompany the text. There is a QR code  at the beginning of each section that will take you to the video lectures.
2. Based on your reading and watching, write down a list of questions. Your questions will probably be answered through the lecture, but if not, you can then ask any questions that are not answered completely. Also, write down any important new vocabulary and formulas in your math notebook.
3. Arrive early and make sure you are mentally prepared for class. Your mind should be alert and ready to concentrate for the entire class. A good night's sleep and healthy meals high in protein can help.

During Class

1. Stay alert. Do not doze off or daydream during class. Understanding the classroom discussion will be very difficult when you "return to class."
2. Avoid distractions such as cell phones and websites that do not pertain to the class.
3. Take thorough notes. It is normal not to understand certain topics the first time you hear them in a lecture. However, this does not mean you should throw your hands up in despair. Rather, continue to take class notes.

Work Smart: Study Skills

Be sure to ask questions during class.

4. Do not be afraid to ask questions. In fact, instructors love questions, for two reasons. First, if one student has a question, other students are likely to have the same question. Second, by asking questions, you teach the teacher what topics cause difficulty.

After Class

1. Reread (and possibly rewrite) your class notes. You may be amazed at how often your confusion during class disappears after studying your in-class notes after class.
2. Reread the section. This is an especially important step. Once you have heard the lecture, the section will make more sense and you will understand much more.

Work Smart: Study Skills

The reason for homework is to build your skills and confidence. Don't skip assignments.

3. Do your homework as soon as possible. **Homework is not optional.** There is an old Chinese proverb that says,

I hear … and I forget
I see … and I remember
I do … and I understand

This proverb applies to any situation in life in which you want to succeed. Would a pianist expect to be the best if she did not practice? The only way you are going to learn algebra is by doing algebra.

4. When you get a problem wrong, try to figure out *why* you got the problem wrong. Once you figure out why, work a similar problem. If you can not discover your error, be sure to ask for help. If possible, connect with others in your class to ask and answer questions about the homework.
5. If you have questions, visit your professor during office hours. You can also ask someone in your study group or go to the tutoring center on campus, if available.

3 How to Use the Text Effectively

This text was developed so that there is more than one way to learn the material. All of the features in the text are here to help you succeed. These features are based on techniques we use in class. The paragraphs that follow outline the features that appear, an explanation of the purpose of each feature, and how each can be used to help you succeed in this course.

Are You Prepared for This Section? Warming Up

Beginning with Section 1.1, each section starts with a short set of review problems. These problems ask questions about material that was presented earlier in the course and is needed for the upcoming section. Complete the problems to be sure you understand the material that the new section is based on. Answers appear as footnotes on the page where the problems appear. Check your answers. If you get a problem wrong, or if you do not know how to do a problem, go back to the section listed and review the material.

Objectives: A "Road Map" Through the Course

To the left of the "Are you Prepared for This Section" problems is a list of objectives to be covered in the section. If you follow the objectives, you will get a good idea of the section's "big picture"—the important concepts, techniques, and procedures that it introduces.

The objectives are numbered. (See the numbered headline at the beginning of this section.) When we begin discussing a particular objective within the section, the objective number appears along with the stated objective.

Examples: Where to Look for Information

Examples are meant to provide you with guidance and instruction when you are away from the instructor and the classroom. With this in mind, we have developed two special example formats.

Step-by-Step Examples have a three-column format. The left column describes a step, the middle column briefly explains the step, and the right column presents the algebra. Thus, the left and middle columns can be thought of as your instructor's voice during a lecture. *Step-by-Step Examples* introduce key topics or important problem-solving strategies. They provide easy-to-understand, practical instructions, and can be identified by the words "How to ..." in the example's title.

Annotated Examples have a two-column format with explanations to the left of the algebra. The explanation clearly describes what operations we are about to perform and the order in which we will do them. Again, annotations are like your instructor's voice as he or she writes each step of the solution on the board.

Authors in Action: Lecture Videos to Help You Learn

In each section there are QR codes that take you to the accompanying video lectures. Every objective has one or more classroom lecture videos, marked by a icon, of the authors teaching their students. These "live" classroom lectures can be used to supplement

your instructor's presentations and your reading of the text. They can also be found in the Multimedia Library of MyMathLab.

In Other Words: Math in Everyday Language

Have you ever been given a math definition in class and said, "What in the world does that mean?" We have heard that from our students. So we added the "In Other Words" feature, which restates mathematical definitions in everyday language. This margin feature will help you understand the language of mathematics better.

Work Smart

These "tricks of the trade" that appear in the margin can help you solve problems. They also show alternative problem-solving approaches. There is often more than one way to solve a math problem!

Work Smart: Study Skills

These margin notes highlight the study skills required for success in this and other mathematics courses.

Exercises: A Unique Numbering Scheme

As teachers, we know that students typically jump right to the exercises after attending class. This means they may skip all of the examples and explanations of concepts in the section. To help you use the book most effectively to learn the math, we have structured the exercises differently from other texts you have used. Our structure is designed to encourage the reading of the book while boosting your confidence and ability to work any mathematical problem. Thus the exercises in each section are broken into as many as eight parts. Each exercise set will have some, or all, of the following exercise types.

1. Quick Checks
2. Building Skills
3. Mixed Practice
4. Applying the Concepts
5. Extending the Concepts
6. Explaining the Concepts
7. Synthesis Review
8. Technology Exercises

1. **Quick Checks: Learning to Ride a Bicycle with Training Wheels** Do you remember when you were first learning to ride a bicycle? Training wheels were placed on the bicycle to assist you in learning balance. The Quick Checks are like exercises with training wheels. These exercises appear right after the example(s) that illustrate the concept being taught. So if you get stuck on a Quick Check problem, you can simply consult the example(s) immediately preceding it, rather than searching through the text. These Quick Checks are intended for you to complete within one day of the class. If you do this, your retention will increase, making the rest of your work much easier! The answers to all Quick Checks are in the back of the book. For an example, see Quick ✓ on page 19 in Section R.3.
2. **Building Skills: Learning to Ride a Bicycle with Assistance** Once you felt ready to ride without training wheels, you probably had an adult follow closely behind you, holding the bicycle for balance and building your confidence. The Building Skills problems serve a similar purpose. They are linked to the objectives within the section, so the directions for a problem indicate which objective is being developed. As a result, you know exactly which objective (but not

exactly which example) to consult if you get stuck. For an example, see page 31 in Section R.3.

3. **Mixed Practice: Now You Are Ready to Ride!** After mastering training wheels and learning to balance with assistance, you are ready to ride alone. This stage corresponds to the Mixed Practice exercises. These exercises include problems that develop your ability to see the big picture of mathematics. They are not linked to a particular objective, and they require you to determine the appropriate approach to solving a problem on your own. For an example, see page 31 in Section R.3.
4. **Applying the Concepts: Where Will I Ever Use This Stuff?** The Applying the Concepts exercises not only illustrate the application of mathematics in your life, but also provide problems that test your conceptual understanding of the mathematics. For an example, see page 32 in Section R.3.
5. **Extending the Concepts: Stretching Your Mind** Sometimes we need to be challenged further. These exercises extend your skills to a new level and provide further insight into where mathematics can be used. For an example, see page 32 in Section R.3.
6. **Explaining the Concepts: Verbalize Your Understanding** These problems require you to express the section's big-picture concepts in your own words. Students need to improve their ability to communicate complicated ideas (both oral and written). If you truly understand the material in the section, you should be able to articulate the concepts clearly. For an example, see page 32 in Section R.3.
7. **Synthesis Review: Seeing the Forest for the Trees** The Synthesis Review exercises, which begin in Chapter 5, can help you grasp the "big picture" of algebra. These exercises ask you to perform a single operation (adding, solving, and so on) on several objects (polynomials, rational expressions, and so on). For an example, see page 409 in Section 5.1.
8. **Technology Exercises** Technology can be a great way to verify answers and to help visualize results. These exercises illustrate how technology, such as graphing calculators or Geogebra, can be incorporated into the material of the section. Sections that include Geogebra exercises will include a URL that will lead you to the Geogebra applet associated with those questions. For an example, see page 120 in Section 1.6.

Chapter Review

The chapter review is arranged by section. For each section, we state key concepts, key terms, and objectives. We also list the examples, the page numbers from the text that illustrate each objective, and the review exercises that assess your understanding of each objective. If you get a problem wrong, use this feature to determine where to look in the book to help you work the problem.

Chapter Test

Once you think you are prepared for the exam, take the chapter test at the end of the chapter. If you do well on the chapter test, chances are you will do well on your in-class exam. Be sure to take the test under the same conditions that you will face in class. For example, try setting a timer to mimic the time constraints felt in class during a test, or take the test at a desk in a quiet room. If you are unsure how to solve a problem in the chapter test, watch the Chapter Test Prep Videos, available in MyMathLab or on YouTube, which show an instructor solving each chapter test problem. These videos can also be accessed by using the QR code found at the beginning of the chapter test.

Cumulative Review: Reinforcing Your Knowledge

The building process of learning algebra involves a lot of reinforcement. For this reason, we provide cumulative reviews at the end of every odd-numbered chapter starting with Chapter 1. Do these cumulative reviews after each chapter test, so that you are always refreshing your memory. This way, studying for the final exam should be easier.

4 How to Prepare for an Exam

The following steps are time-tested suggestions to help you prepare for an exam.

Step 1: **Revisit your homework and the chapter review problems.** About one week before your exam, start to redo your homework assignments. If you do not understand a topic, seek out help. Work the problems in the chapter review as well. These problems are linked to the section objectives. If you get a problem wrong, identify the objective and the examples that illustrate the objective. Then review this material and try the problem in the chapter review again. If you still get the problem wrong, seek out help.

Step 2: **Test yourself.** A day or two before the exam, take the chapter test under test conditions. For example, this means if your test is timed, to time yourself; if you are only allowed certain resources for the exam, only use those resources. Be sure to check your answers in the back of the book or the Chapter Test Prep Videos. If you get any problems wrong, determine why and remedy the situation. Do not gamble on what might be on the exam; master everything.

Step 3: **View the Chapter Test Prep Videos.** These videos show step-by-step solutions to the problems found in each of the book's chapter tests. Follow the worked-out solutions to any of the exercises on the chapter test that you want to study or review.

Work Smart: Study Skills
Do not "cram" for an exam by pulling an "all-nighter."

Step 4: **Arrive early and well rested to the exam.** Be sure to arrive early at the location of the exam. Prepare your mind for the exam. Be sure you are well rested. Do not try to pull "all-nighters." It does not work since your brain can only process a certain amount of material at a time. You should be reviewing material you already know the night before an exam, not learning new material.

R.1 Exercises MyMathLab®

1. Why do you want to be successful in mathematics? Are your goals positive or negative? If you stated your goal negatively ("Just get me out of this course!"), can you restate it positively?

2. Name three activities in your daily life that involve the use of math (for instance, playing cards, operating your computer, or reading a credit card bill).

3. What is your instructor's name?

4. What are your instructor's office hours? Where is your instructor's office?

5. What is your instructor's e-mail address?

6. Does your class have a website? Do you know how to access it? What information is located on the website?

7. Are there tutors available for this course? If so, where are they located? When are they available?

8. Name two other students in your class. What is their contact information? When can you meet with them to study?

9. List at least two things that you should do before class begins.

10. List at least two things you should do during class.

11. List at least two things you should do after class.

12. What is the point of the Chinese proverb on page 3?

13. What are the "Are you Prepared for This Section" problems? How should they be used?

14. Name two features that appear in the margins. What is the purpose of each of them?

15. Name the categories of exercises that appear in this book.

16. How should the chapter review material be used?

17. How should the chapter test be used?

18. What are the Chapter Test Prep Videos? How can you access them?

19. List the four steps that should be followed when preparing for an exam. Can you think of other methods of preparing for an exam that have worked for you?

20. How is mathematics like doing crunches at the gym?

21. Use the chart to help manage your time. Be sure to fill in the time allocated to various activities in your life, including each of your classes, studying, work, and leisure. Remember, for every hour you are in class, you should spend two hours outside of class studying the material.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7 am							
8 am							
9 am							
10 am							
11 am							
Noon							
1 pm							
2 pm							
3 pm							
4 pm							
5 pm							
6 pm							
7 pm							
8 pm							
9 pm							

R.2 Sets and Classification of Numbers

Objectives

1. Use Set Notation
2. Classify Numbers
3. Approximate Decimals by Rounding or Truncating
4. Plot Points on the Real Number Line
5. Use Inequalities to Order Real Numbers

1 Use Set Notation

A **set** is a well-defined collection of objects. "Well-defined" means that there is a rule for determining whether a given object is in the set. For example, the students enrolled in Intermediate Algebra at your college is a set. The collection of numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 may also be identified as a set. If D represents this set of numbers, then

$$D = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$$

This notation uses braces { } to enclose the objects, or **elements,** in the set. This method of representing a set is called the **roster method.**

EXAMPLE 1 Using the Roster Method

Write the set that represents the vowels.

Solution

The vowels are a, e, i, o, and u, so write

$$V = \{a, e, i, o, u\}$$

In Other Words
The symbol "|" means "such that", so read the set to the right as "D is the set of all x such that x is a digit."

Another way to denote a set is to use **set-builder notation.** The numbers in the set $D = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ are called digits. Using set-builder notation, the set D of digits can be written as

$$D = \{x | x \text{ is a digit}\}$$

In algebra, letters such as x, y, a, b, and c are used to represent numbers. When the letter can be any number in a set of numbers, it is called a **variable.** In the set D, the letter x can represent any digit, so x is a variable that can take on the value 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9.

EXAMPLE 2 Using Set-Builder Notation

Use set-builder notation to represent the following sets.

(a) The set of all even digits

(b) The set of all odd digits

Solution

(a) Let E represent the set of all even digits, so that

$$E = \{x | x \text{ is an even digit}\}$$

(b) Let O represent the set of all odd digits, so that

$$O = \{x | x \text{ is an odd digit}\}$$

Quick ✓

1. A ___ is a well-defined collection of objects.

2. The objects in a set are called _____.

In Problems 3 and 4, use set-builder notation and the roster method to represent each set.

3. The set of all digits less than 5

4. The set of all digits greater than or equal to 6

When the elements in a set are listed, an element is never listed more than once. For example, do not write $\{1, 2, 3, 2\}$; write $\{1, 2, 3\}$. Also, the order in which the elements are listed does not matter. For example, $\{2, 3\}$ and $\{3, 2\}$ represent the same set.

More notation for describing sets will now be introduced.

Set Notation

- If two sets A and B have the same elements, then say that A **equals** B and write $A = B$.
- If every element of a set A is also an element of a set B, then say that A is a **subset** of B and write $A \subseteq B$.
- If $A \subseteq B$ and $A \neq B$, then say that A is a **proper subset** of B and write $A \subset B$. Put another way, A is a proper subset of B if all elements in A are also in B and there are elements in B that are not in A.
- If a set A has no elements, it is called the **empty set,** or **null set,** and is denoted by the symbol $\emptyset$ or $\{\ \}$. The empty set is a subset of every set; that is $\emptyset \subseteq A$ for any set A.

Work Smart
The empty set is represented as either $\emptyset$ or $\{\ \}$. Never write $\{\emptyset\}$ to represent the empty set because this notation means a set that contains the set called the empty set.

When working with sets, we usually designate a **universal set,** which is the set of all elements of interest to us. For instance, in Example 2, we were interested in the set of all digits, so the universal set is the set of all digits.